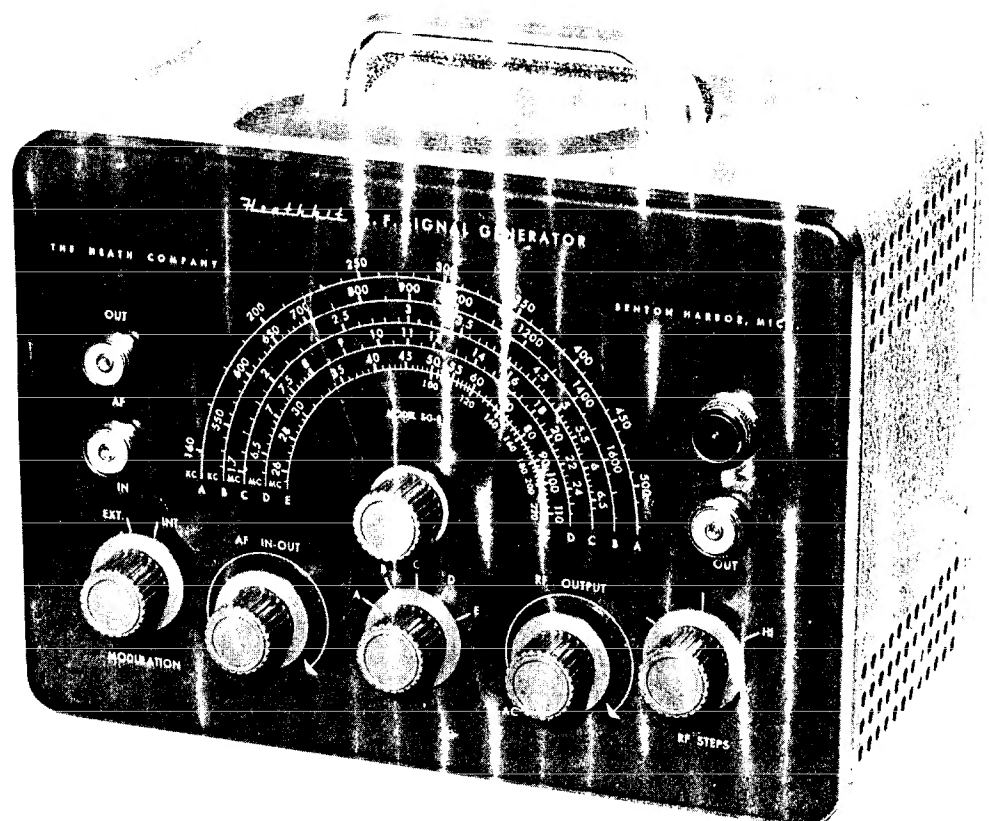


# ASSEMBLY AND OPERATION OF THE HEATHKIT SIGNAL GENERATOR

## MODEL SG-8



### SPECIFICATIONS

#### Frequency Range

Band A.....	160 kc to 500 kc
Band B.....	500 kc to 1650 kc
Band C.....	1.65 mc to 6.5 mc
Band D.....	6.5 mc to 25 mc
Band E.....	25 mc to 110 mc

Calibrated Harmonics.....110 mc to 220 mc

Radio Frequency Output.....In excess of 100,000 microvolts

Modulation Frequency.....Approximately 400 cycles

Audio Output.....2 to 3 volts

Audio Frequency Input.....Approximately 5 v across 1 megohm

#### Tubes

12AU7.....RF Oscillator-Buffer

6C4.....Audio Oscillator or Audio Amplifier

Power Requirements.....105-125 v, 50/60 cycles

Cabinet Size.....9 1/2 wide x 6 1/2 high x 5 deep

Shipping Weight.....7 lbs.



## INTRODUCTION

The Heathkit model SG-8 Signal Generator has been designed for simplicity of construction and stability of operation. A little care taken during the process of construction will reward the kit builder with a signal generator which will give excellent performance and will be both pleasant and easy to use. This generator has been engineered so that it will be valuable to the radio repairman, ham and experimenter over a wide range of uses, in addition to being a rugged and highly dependable piece of test equipment. It is made with high quality parts, conservatively rated, and will give long and efficient service. The model SG-8 Signal Generator utilizes factory adjusted coils, thereby eliminating the necessity of having costly equipment available to calibrate the finished kit.

## CIRCUIT DESCRIPTION

The RF portion of the SG-8 Signal Generator consists of a 12AU7 twin triode tube. One triode section of this tube is used as a Colpitts oscillator. The other triode section is used in a cathode follower type circuit and acts as a buffer between the oscillator and the output of the signal generator. Four inductances wound on forms comprise the coils for bands A, B, C and D. They are switched into the circuit by means of the band switch. The E band coil is unique in its construction insofar that the heavy buswire of which it is composed actually forms the connections between the band switch and the tuning condenser for all of the lower frequency coils. When the band switch is placed in E band position, a short is placed across the leads of the E band coils, thereby making it a closed circuit inductance which is capable of tuning from 25 to 100 megacycles.

In a Colpitts oscillator circuit, feedback necessary to maintain oscillations is obtained from a capacitive reactance divider across the inductance of the frequency determining circuit. In the model SG-8, a capacitive divider is obtained by the use of a split-stator condenser. The advantage of this will be made apparent from the following explanation. For example, take a capacitive divider composed of fixed capacities. As the frequency across the condensers is increased, the reactance of the condensers is decreased. Therefore, using a fixed capacitive divider, as the frequency is increased reactance would become lower until a point was reached where oscillations could no longer be maintained. By the use of a split-stator condenser for both tuning and as the divider network as the frequency is increased, the capacity of the condenser dividing network is decreased. The reactance of a condenser for any given frequency is inversely proportional to the capacity. This tends to maintain the reactance of the network fairly constant, thereby permitting oscillation over a wide range of frequency.

The use of the cathode follower as a buffer stage has the following advantage: The characteristics of a "cathode follower" are very low output impedance with an extremely high input impedance. The extremely high input impedance produces little or no loading on the oscillator circuit. The very low output impedance provides a very stable output from the signal generator. The effect is such that a varying load on the output of the signal generator will produce little or no frequency instability of the oscillator. The signal generator incorporates a step attenuator for coarse control of radio frequency output and a continuously variable attenuation circuit for fine control of the radio frequency output.

The audio oscillator is also a Colpitts circuit. By the use of the large inductance of an iron-core choke and relatively high capacity in the capacitive divider, it is made to oscillate at approximately 400 cycles. This type of oscillator was again chosen for its stability and purity of waveform. With the modulation switch in the INT. position, 400 cycles audio voltage is applied through a resistance network to the grid of the cathode follower stage. This audio voltage is impressed as an amplitude modulated signal upon the RF output from the cathode follower.

At the same time the audio voltage is also applied to the external audio connector marked OUT, and may be used as an audio signal source for testing amplifiers, etc. With the modulation switch in the EXT. position, any external audio source of any frequency may be used to modulate the RF output of the signal generator. The 6C4 audio oscillator tube then becomes an amplifier stage for the external signal.

The power supply consists of a transformer which furnishes filament voltage to the 6C4 and 12AU7 tubes and effectively isolates the instrument from the AC line. A selenium rectifier is connected to one winding of the transformer producing half-wave rectification. An RC filter network changes the pulsed output from the rectifier to fairly pure DC. The 110 volt input has both sides bypassed to minimize the signal feeding back through the power lines.

A unique design feature is the convenient AF IN-OUT control, which adjusts audio input if external modulation is employed and likewise adjusts the AF output level when using the generator as a source of audio output.

### PRELIMINARY INSTRUCTIONS AND NOTES

The Heathkit model SG-8 Signal Generator when constructed in accordance with the instructions in this manual, is a high-quality piece of test equipment, capable of years of trouble-free service. We therefore urge you to take the necessary time to assemble and wire the kit carefully. You will be rewarded with a neat appearing, well-built and dependable test oscillator.

This manual is supplied to assist you in every way to complete the signal generator with the least possible chance for error. We suggest that you take a few minutes now and read the entire manual through before any work is begun. This will enable you to proceed with the work much faster when construction is started. The large, fold-in pictorials are handy to attach to the wall above your work space. Their use will greatly simplify the construction of the kit. These diagrams are repeated in smaller form within the manual. We suggest that you retain the manual in your files for future reference, both in the use of the signal generator and for its maintenance.

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with each part. Refer to the charts and other information shown on the inside covers of the manual to help you identify any parts about which there may be a question. If some shortage is found in checking the parts, please notify us promptly and return the inspection slip with your letter to us. Hardware items are counted by weight, and if a few are missing, please obtain them locally if at all possible.

Read the note on soldering on the inside of the backcover. Crimp all leads tightly to the terminal before soldering. Be sure both the lead and the terminal are free of wax, corrosion, or other foreign substances. Use only the best rosin core solder, preferably a type containing the new activated fluxes, such as Kester "Resin-Five," Ersin "Multicore," or similar types.

**NOTE: ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. WHEN IN DOUBT ABOUT SOLDER, IT IS RECOMMENDED THAT A NEW ROLL PLAINLY MARKED "ROsin CORE RADIO SOLDER" BE PURCHASED.**

Resistors and condensers generally have a tolerance rating of  $\pm 20\%$  unless otherwise stated in the parts list. Therefore a 100 K $\Omega$  resistor may test anywhere from 80 K $\Omega$  to 120 K $\Omega$ . (The letter K is commonly used to designate a multiplier of 1000.) Tolerances on condensers are generally even greater. Limits of +100% and -50% are common for electrolytic condensers. The parts furnished with your Heathkit have been specified so they may not adversely affect the operation of the finished signal generator.

In order to expedite delivery to you, we are occasionally forced to make minor substitutions of parts. Such substitutions are carefully checked before they are approved, and the parts supplied will work satisfactorily. By checking the parts list for resistors, for example, you may find that a 2.2 megohm resistor has been supplied in place of a 2 megohm as shown in the parts list. These changes are self-evident and are mentioned here only to prevent confusion in checking the contents of your kit.

We strongly urge that you follow the wiring and parts layout shown in the manual. The position

## TEST LEAD ASSEMBLY

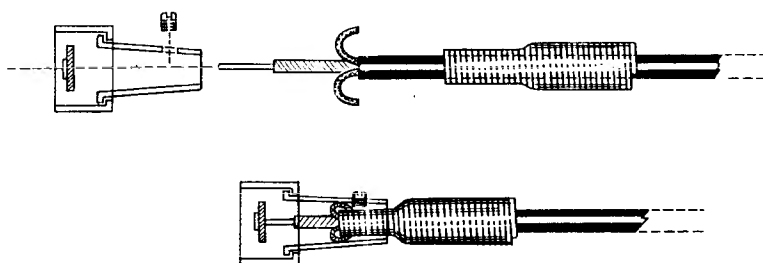


Figure 11

The test lead is assembled as shown in Figure 11. One end of the shielded cable is connected to the shielded plug; the other end has alligator clips mounted on it for connection to the equipment under test. First, remove the spring cable guard from the connector plug by loosening the screw in the side of the plug. Slide this spring over the shielded cable, with the small end of the spring toward the end that is to be connected to the plug. The outside insulation on the cable is then cut back for a length of about  $3/4$ ", then flare the shield braiding at the end of the cable so that it may be pushed back over the small end of the spring cable guard. The inner connector is then stripped for a length of approximately  $1/8$ ". The assembly at this point is slid back into the connector so that the inner coaxial wire passes through the rivet in the insulated end of the connector, the cable guard with the shielded braid flared over the end is pushed back into the connector and the screw tightened to hold it in place. Solder the inner connector.

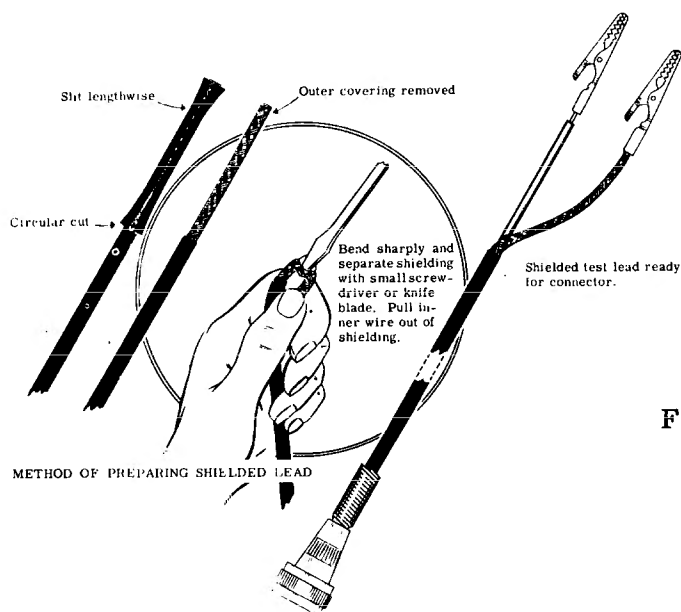


Figure 12

On the other end of the shield cable, the outer insulation is cut back about 4" and the cable prepared as shown in Figure 12. Solder alligator clips to both the inner conductor and the shield braid.

## ACCURACY

Any signal generator is designed as a convenient and controllable source of modulated or unmodulated signals. No signal generator is designed as a frequency standard. Expensive standard signal generators have fairly accurate (3 to 20%) attenuators which control the output voltage and the calibration accuracy is rarely closer than 1%. The Heathkit Signal Generator may be expected to fall within 2 to 3% of the frequency calibration, which is quite satisfactory for service work and alignment. In receiver adjustment, the frequency at which the particular adjustment is made is rarely critical but the adjustment itself for maximum signal output from the

receiver is frequently quite critical. For accurate calibration of homebuilt receivers or equipment, proceed as follows. Make a rough calibration with the signal generator. Then, with a receiver, tune in WWV (Bureau of Standards) at 2.5, 5, or 10 mc. Set the signal generator to a suitable sub-harmonic, such as 500 or 1000 kc, and adjust the generator for zero beat. Now harmonics of the signal generator occur every 500 kc or 1 megacycle, and these harmonics may be used to give accurate calibrations at points 500 or 1000 kc apart, such as 2500 kc, 3000 kc, 3500 kc, 4000 kc, etc. These known frequency points can be marked on the dial of the equipment being calibrated. The object of the rough calibration is merely to furnish a means of identifying for example, the 3000 kc point from the 2500 kc or 3500 kc points. For calibration of higher frequency equipment, a choice of higher sub-harmonic will reduce the confusion between the multitude of harmonics and will also insure adequate signal strength. When checking the calibration accuracy of the Heathkit Signal Generator, the most convenient standards of comparison of sufficient accuracy are broadcast stations of known frequency. Crystal oscillators of standard frequency when zero beat against WWV, are also convenient to use if available. The use of receiver dial calibrations is frequently not of sufficient accuracy to warrant consideration.

**Output Voltage:** The RF signal strength going into the output control depends upon the strength of oscillation of the 12AU7 oscillator. In all variable frequency oscillators the amplitude will vary with the tuning condenser setting. With careful design the variation may be minimized. In the Heathkit Signal Generator, the variation is kept down to a ratio of about 2 1/2 to 1 on each band except band E, where the L/C (inductance to capacitance) ratio becomes sufficiently unfavorable that oscillation may drop off rapidly in strength when the condenser is near maximum capacity. However, even on this band, the output of the SG-8 is in excess of 100,000 microvolts which is more than sufficient for the average application in which this generator will be used.

#### IN CASE OF DIFFICULTY

1. Recheck the entire wiring. Follow each lead and color it on the pictorial with a colored pencil. If possible, have a friend recheck the wiring for you. Most cases of difficulty result from wrong or reversed connections. In this unit, there is also the possibility of shorts to the chassis occurring on some of the bare wire connections from the coils. These wires should be carefully spaced away from the chassis when the instrument is assembled.
2. Check the test lead with an ohmmeter to be sure there are no shorts between the inner and outer conductor caused by overheating during the soldering process.
3. If the wiring is found to be correct and the signal generator still refuses to work, try changing tubes. It is possible that one of the tubes is defective.
4. Check the voltages. A voltage chart is included showing the normal voltage to be expected at the pins of the tube sockets. These voltages were measured with an 11 megohm input vacuum tube voltmeter. A normal variation of  $\pm 15\%$  is to be expected. With regular voltmeters, readings may be very much lower. All voltages are DC unless otherwise indicated.
5. If only one band on the signal generator is inoperative, it is very likely that the coil associated with that band has become damaged. An ohmmeter connected between the terminals of the coil should show continuity. If it does not, one section of the winding is open.

#### VOLTAGE CHART

TUBE	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
6C4	65	NC	6.3 AC	0	65	-0.5	1		
12AU7	78	*-2 to -15	3.5	6.3 AC	6.3 AC	*75-85	*-3 to -30	0	0

\*Dependent upon frequency.

NC - no connection.

#### BIBLIOGRAPHY

Marcus and Levy; Elements of Radio Servicing  
 Kiver, Milton S.; How to Understand and Use TV Test Instruments  
 Johnson, J. Richard; How to Use Signal and Sweep Generators

## USE OF THE I F SIGNAL GENERATOR

This signal generator can be used to align radio receivers. It furnishes a source of radio frequency or modulated radio frequency by means of signal generator fundamental frequencies between 160 kc and 100 megacycles (1 megacycle equals 1000 kilocycles) and useful harmonics of the signal generator may be used to over 200 megacycles.

The RF Signal Generator will be found a most valuable aid to the radio service man as well as the hobbyist. The day-to-day "bread and butter" job of the signal generator is receiver alignment. To save time and money, the service man or hobbyist should use a technique which can be applied to the majority of sets encountered in normal work. After using the technique a few times, it becomes virtually a matter of "second nature" and so easily used that the average set may be completely aligned in a matter of minutes.

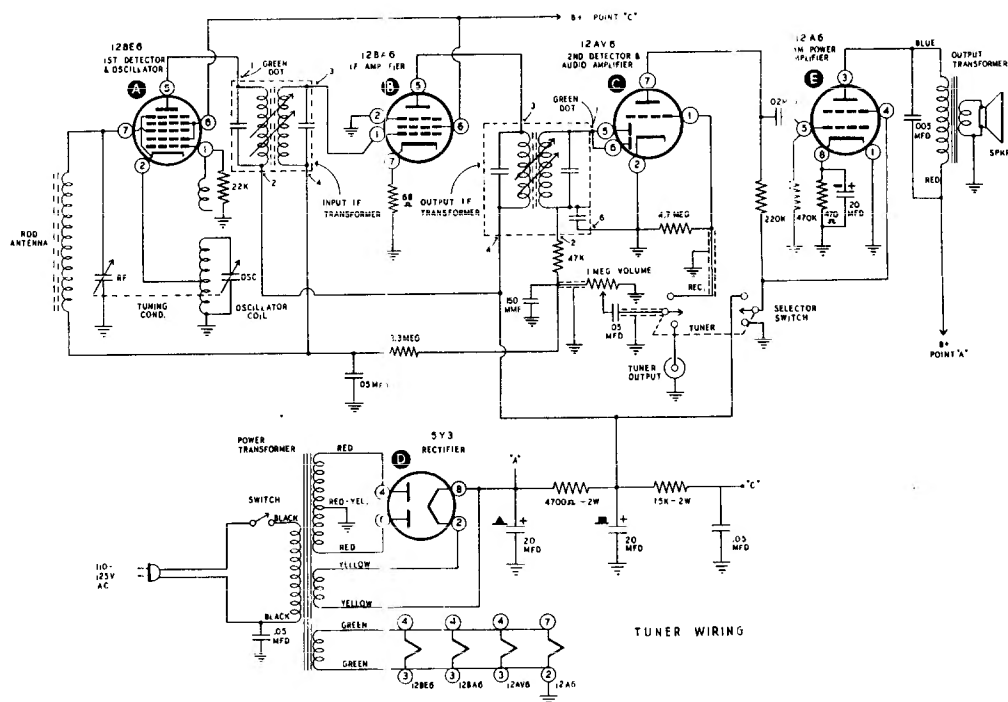
The majority of single band radio receivers have nowadays become quite standardized and therefore it is seldom necessary in alignment of receivers to refer to the specific manufacturer's alignment instruction. In the average receiver, it is generally only necessary to take note of the IF frequency (most home radios and automobile radios employ a 455 KC IF frequency).

Figure 13 is a schematic diagram of a small, single-band superheterodyne radio receiver. The majority of single-band sets use a circuit similar to this one. Variations likely to be found are as follows:

- (1) Use of an antenna coil rather than a rod-type or loop antenna.
- (2) Use of a separate oscillator rather than a pentagrid converter.
- (3) Trimmer tuning of IF and RF stages in place of iron core slugs.
- (4) Use of an RF stage ahead of the mixer.
- (5) More than one IF stage.

These variations do not appreciably affect the alignment technique and the following step-by-step procedure may be used directly in most cases:

- (1) Turn both the signal generator and the receiver on and allow several minutes for both units to reach normal operating temperature. (It is a good idea to leave the signal generator on during all working hours.)



**Figure 13**

- (2) Connect an output indicator to the receiver. This may be an AC voltmeter connected directly across the loudspeaker voice coil; however, a VTVM connected to measure AVC voltage is by far the most desirable method.
- (3) Short out the local oscillator tuning circuit temporarily. The simplest way to accomplish this is merely by clipping a short piece of wire across the rotor and stator plates of the oscillator section of the tuning condenser. Set the receiver dial to the low frequency end, somewhere near 550 KC.
- (4) Connect the signal generator to the antenna terminals of the receiver or if the receiver employs a loop antenna or rod antenna, couple the output of the generator to the antenna system through a one or two turn loop of wire around the antenna. In cases where an RF stage is used ahead of the mixer, connect the signal generator to the injection grid of the mixer stage. Set the signal generator to the IF value of the set. (455 KC is generally the accepted standard.) Use a modulated signal if an AC voltmeter is employed as an output indicator. An unmodulated signal is used provided the AVC voltage is used as an output indication.
- (5) Using the lowest range of the output indicator, increase the output of the signal generator until a reading can just be obtained.
- (6) Adjust the IF transformers for maximum reading on the output indicator. Reduce the signal generator output as necessary to keep a low reading on the output indicator. Repeat the adjustments at least once to correct for any interaction between primary and secondary windings on the individual transformers. Interaction is most likely to occur in sets where adjustment is by means of iron-core slugs rather than trimmer condensers.
- (7) Next, remove the short across the local oscillator and tune the receiver to its highest frequency setting (somewhere around 1600 KC). Set the signal generator to the same frequency and adjust the oscillator trimmer for maximum output.
- (8) Now tune the receiver and signal generator to 1400 KC and adjust the RF trimmer for maximum output.
- (9) Turn the signal generator to 600 KC and tune the receiver to the low frequency end of the dial. Now "rock" the receiver tuning condenser while at the same time adjusting the trimmer condenser for maximum output. In sets using especially shaped plates in the oscillator section of the tuning condenser, generally no trimmer condenser will be found. Also, in some sets, the low frequency oscillator adjustment will be through means of an iron-core slug in the oscillator coil rather than a trimmer condenser.
- (10) Steps 7, 8 and 9 should be repeated if it was found necessary to readjust the trimmer condenser (or iron-core slug) as directed in Step 9.

The alignment procedure for multi-band AM superheterodyne receivers is essentially the same as outlined above for a single-band set. First the IF stages are aligned using the same technique as given in Steps 1 through 6. Next, each RF band is aligned separately, starting with the highest frequency band and working towards the lowest. The technique given may be used but with corresponding frequency settings for each band.

If the oscillator and IF trimmer condensers for the different bands are not well identified, a simple technique may be employed to locate the proper adjustment screws. Turn the receiver band switch to the highest frequency band and tune in a signal, using a short-wave station or a signal from the RF generator. Using an insulated alignment tool, try compressing the different oscillator trimmers until one is found that changes the tuning of the signal. Do not compress the oscillator trimmer condensers by turning the adjustment screws, just press the leaves of the condenser together temporarily. This method will identify the trimmers for each band without drastically changing their original setting. After identifying the oscillator trimmer for the band in this manner, repeat the technique to identify the RF trimmer. Turn to the next band and repeat the method being careful not to touch the trimmers already identified.



Should the oscillator trimmer of the short-wave band have a wide tuning range, it may be possible to pick up and "peak" a signal with two different settings of the trimmer. Should this be the case, use the setting with the least capacity to insure that the oscillator is tuned above the incoming signal.

### FM RECEIVER ALIGNMENT

It is the standard practice to align the IF amplifier of an FM receiver (tuner) before aligning the RF and oscillator sections just as in AM receivers. However, the exact technique of alignment depends on whether a limiter discriminator or a ratio detector is used. Where a limiter and discriminator are used, usual practice is to align the IF section up to the input of the limiter first. Then align the discriminator as a separate step. When aligning the IF, RF and oscillator sections, the grid current of the limiter may be used as an output indicator. Although the voltage across a limiter grid resistor, measured with a VTVM, will serve in many cases, it is not an ideal indication. A typical limiter and discriminator stage is shown in Figure 14. Proper alignment technique for the complete FM receiver is as follows:

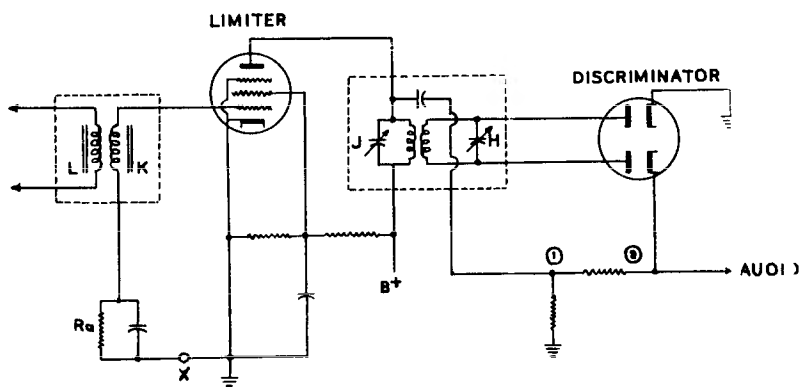


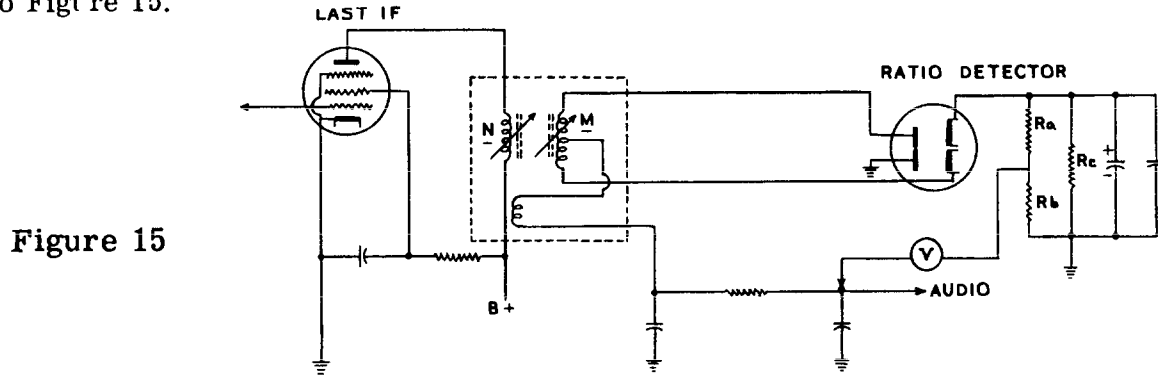
Figure 14

- (1) Connect an output indicator by (1) attaching a VTVM across the limiter grid resistor, or (2) breaking the circuit at the grid of the limiter and inserting a microammeter with a maximum range of around 150 microamps. If this method is used, be sure and bypass the meter with a .05  $\mu$ f capacitor to ground. See point X in Figure 14.
- (2) Connect a signal generator to the input of the mixer stage and turn on both the signal generator and the receiver. A sufficient warm-up time must be allowed to permit both the receiver and the generator to reach their normal operating temperature. In the case of FM receivers this is usually 15 to 20 minutes before complete stabilization can be obtained. Adjust the signal generator to the IF value of the set. This is usually 10.7 mc. The unmodulated RF output of the signal generator is used.
- (3) Peak all IF trimmers for maximum meter readings. If the IF is considerably out of alignment so that very little meter reading is obtained, it may be necessary to connect the signal generator to the last IF stage and align this portion of the circuit first. Then work back toward the mixer stage, rechecking previous IF adjustments at each point.
- (4) Connect a VTVM between point 1 and ground as shown in Figure 14. Adjust the trimmer or slug "J" for maximum reading using a low VTVM range.
- (5) Transfer the VTVM connection to point 2 and adjust trimmer "H" for a minimum voltmeter reading.

- (6) Transfer the signal generator lead to the antenna terminals and align the RF and oscillator trimmers, using essentially the same technique as is outlined for AM receiver adjustment, except the frequency settings will fall between 88 mc and 108 mc. The output indicator for this adjustment is the same as discussed in Step 1. Lastly, adjust the antenna trimmer for maximum indication or volume using the receiver's own antenna and at its permanent location.

### RATIO DETECTORS

The following technique may be used for alignment of ratio detector FM receiver circuits. Refer to Figure 15.



- (1) Connect a VTVM or high resistance DC voltmeter across RC.
- (2) As before, both receiver and signal generator should be allowed to warm up. The receiver dial should be set to the low frequency end (88 mc) and the signal generator adjusted to give an unmodulated signal at the receiver IF. Connect the signal generator to the input of the mixer stage as before.
- (3) Adjust all IF trimmers (or slugs) for a maximum reading on the meter, using a low range and the least signal generator output possible. Repeat the adjustments at least twice to correct for any interaction. Be sure slug N is accurately adjusted.
- (4) Connect two 100,000  $\Omega$  1/2 watt resistors across RC (RA and RB) and connect the voltmeter as shown in Point V in Figure 15.
- (5) Adjust the trimmer (or slug) M for a zero output indication on the meter.
- (6) Align the RF and oscillator stages using the techniques previously described, measuring the voltage across RC as an output indication.

### SERVICING BY SIGNAL INJECTION

#### THE AUDIO AMPLIFIER

The block diagram for a typical audio amplifier is shown in Figure 16. Let us assume, for the moment, that the amplifier is "dead" due to a defective second audio stage.

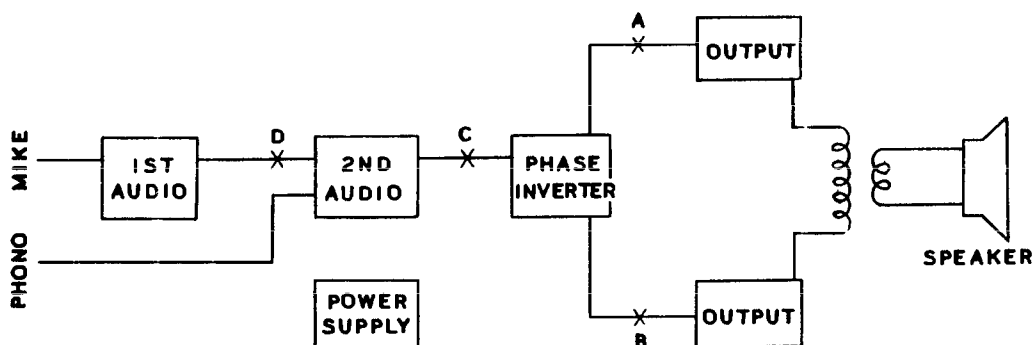


Figure 16

In servicing the equipment, the first step, of course, is to check for obvious defects such as lack of B plus, defective tubes and so forth. After these preliminary tests have been made, the Heathkit RF Signal Generator is used as an audio signal source by plugging the output cable into the "AF-OUT" jack. The level of the audio tone obtained is adjusted by the "AF IN-OUT" control. The MODULATION control should be set in the "INT." position.

Check the operation of the output stages by connecting the ground lead of the output cable to the chassis of the amplifier or circuit ground and touching the "hot" lead of the output cable to the grid of first one output tube Point A in Figure 16 then to the other output tube Point B in Figure 16. All of these tests must be made through a .05  $\mu$ fd condenser. In this fashion the operation of each output stage is checked individually. As each grid is touched, a clear audio tone should be heard in the loudspeaker.

Next, the operation of the phase inverter stage can be checked by transferring the hot lead (together with a .05  $\mu$ fd condenser) to the input of this stage (Point C in Figure 16). Again, a clear signal should be heard from the loudspeaker. The tone should be louder than before. If too loud, the volume can be reduced, using the "AF IN-OUT" control.

The second audio stage is now checked by transferring the hot signal generator lead to the input of this stage, Point D in Figure 13. If this stage is dead, no more tone will be heard in the loudspeaker. Having isolated the trouble to a specific stage, it is now a simple matter to check DC operating voltages and parts until the defective component is found.

As each amplifier stage is checked, work back towards the input stage (first audio), a definite increase in volume should have been noted. It may even be necessary to reduce the volume using the control mentioned. This, then, provides an additional test technique. A weak stage can be identified if little or no increase in volume is heard as the "hot" lead is transferred past the stage. Be careful when interpreting the results of this test, for overloading a stage may cause apparent loss in volume even when the stage itself is in good condition. Therefore, when attempting to isolate a "weak" stage, be sure to keep the signal level at a reasonable point.

AN OPEN COUPLING CONDENSER may be isolated using this signal injection technique. Refer to Figure 17, which is part of a conventional resistance coupled amplifier. If coupling condenser C-1 should open, little or no signal would be transferred between stages. To check the condition of the coupling condenser, it is first necessary to connect a small blocking condenser in series with the "hot" lead of the signal generator. The condenser may have a value of .05  $\mu$ fd. The exact value is not at all critical. The blocking condenser permits the "hot" lead to be placed on the plate of a tube without danger of the DC voltage present injuring circuits within the generator.

If a clear tone is heard when the "hot" lead is touched to Point E but not when touched to Point F, we are reasonably sure Condenser C-1 is open.

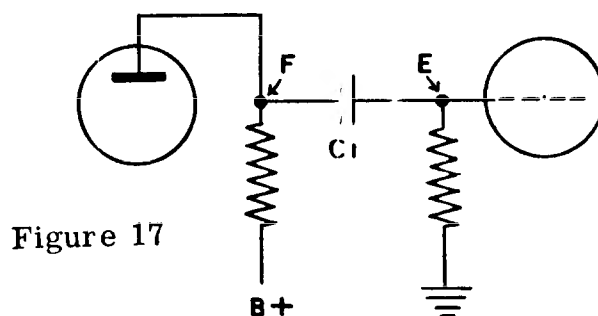


Figure 17

## RADIO RECEIVER

Referring to the block diagram for a typical small AM receiver, Figure 18, again the technique of signal injection, is essentially the same as that used in the case of the audio amplifier. That is, a substitute signal is injected into each stage starting at a convenient point and working back towards the "front" of the equipment. In the case of the audio amplifier, we work towards the input jack of the amplifier. In the case of the radio receiver, we work towards the antenna.

There is one important difference between using the signal injection technique on an audio amplifier and using the same technique on a receiver. In the case of the amplifier as we have seen, the audio output signal obtained from the signal generator was used exclusively; however, when trouble-shooting a receiver, it becomes necessary to switch to an RF signal when checking stages

ahead of the second detector. In addition, the frequency of the RF signal will have to be changed to match the operating frequency of the stages being checked. A rather common receiver complaint is that the "set is dead". When such a complaint is caused by a defective local oscillator, the trouble may prove somewhat difficult to isolate.

As before, the first step in servicing the equipment is to check for the obvious defects. A quick check with a DC voltmeter will indicate whether or not the power supply is operating.

To isolate the trouble to a stage as rapidly as possible, a technique which experienced service men often employ may be used. Instead of stage-by-stage testing, the set is considered to consist of major sections and primarily isolation of the trouble may be made on this basis. The audio signal obtained from the Heathkit RF signal generator may be used to inject a signal at the input of the first audio stage (Point H in Figure 18). If a loud clear tone is heard, we know immediately that the entire audio section of the receiver is operating and can forget about these stages for the time being.

Shift the output cable of the signal generator to the RF OUT jack and adjust the controls to give a modulated RF signal at the IF value for the receiver. (In most cases this will be 455 KC). Using a 50  $\mu$ f condenser in series with the "hot" lead, inject the signal at the input of the IF stage (Point J in Figure 18). The use of a small coupling condenser in this case is to minimize detuning of the IF and RF stages for the signal generator lead. If a tone is once again heard in the loudspeaker, we know that the IF stage, under test, is in satisfactory operation.

Repeat the signal injection tests until the defective stage in the receiver has been located. From this point on, then, it is a simple matter to isolate the defective components causing the receiver to be inoperative.

Variations of a signal injection technique may be used for servicing FM and TV receivers as well as the herein discussed AM receivers and audio amplifiers.

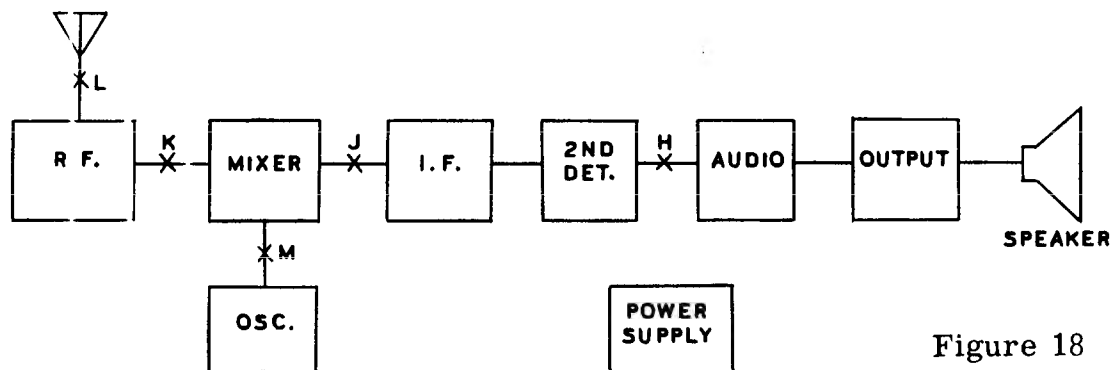


Figure 18

#### REPLACEMENTS

Material supplied with Heathkits has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally improper instrument operation can be traced to a faulty tube or component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all of the following information:

- A. Thoroughly identify the part in question by using the part number and description found in the manual parts list.
- B. Identify the type and model number of kit in which it is used.
- C. Mention the order number and date of purchase.
- D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. Please do not return the original component until specifically requested to do so. Do not dismantle the component in

question as this will void the guarantee. If tubes are to be returned, pack them carefully to prevent breakage in shipment as broken tubes are not eligible for replacement. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

#### SERVICE

In event continued operational difficulties of the completed instrument are experienced, the facilities of the Heath Company Service Department are at your disposal. Your instrument may be returned for inspection and repair for a service charge of \$3.00 plus the cost of any additional material that may be required. **THIS SERVICE POLICY APPLIES ONLY TO COMPLETED INSTRUMENTS CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL.** Instruments that are not entirely completed or instruments that are modified in design will not be accepted for repair. Instruments showing evidence of acid core solder or paste fluxes will be returned not repaired.

The Heath Company is willing to offer its full cooperation to assist you in obtaining the specified performance level in your instrument. Factory repair service is available for a period of one year from the date of purchase or you may contact the Engineering Consultation Department by mail. For information regarding possible modification of existing kits, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at any electronic outlet store. Although the Heath Company sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for specific purposes. Therefore, such modifications must be made at the discretion of the kit builder according to information which will be much more readily available from some local source.

#### SHIPPING INSTRUCTIONS

Before returning a unit for service, be sure that all parts are securely mounted.

**ATTACH A TAG TO THE INSTRUMENT GIVING  
NAME, ADDRESS AND TROUBLE EXPERIENCED.**

Pack in a rugged container, preferably wood, using at least three inches of shredded newspaper or excelsior on all sides. **DO NOT SHIP IN THE ORIGINAL KIT CARTON AS THIS CARTON IS NOT CONSIDERED ADEQUATE FOR SAFE SHIPMENT OF THE COMPLETED INSTRUMENT.** Ship by prepaid express if possible. Return shipment will be made by express collect. Note that a carrier cannot be held liable for damage in transit if packing, in HIS OPINION, is insufficient.

#### SPECIFICATIONS

All prices are subject to change without notice. The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

### WARRANTY

Heath Company warrants that for a period of three months from the date of shipment, all Heath kit parts shall be free of defects in materials and workmanship under normal use and service and that in fulfillment of any breach of such warranty, Heath Company shall replace such defective parts upon the return of the same to its factory. The foregoing warranty shall apply only to the original buyer, and is and shall be in lieu of all other warranties, whether express or implied and of all other obligations or liabilities on the part of Heath Company and in no event shall Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of Heath kits or components thereof. No replacement shall be made of parts damaged by the buyer in the course of handling or assembling Heath kit equipment.

NOTE: The foregoing warranty is completely void and we will not replace, repair or service instruments or parts thereof in which acid core solder or paste fluxes have been used.

HEATH COMPANY

PART No.	PARTS Per Kit	DESCRIPTION	PART No.	PARTS Per Kit	DESCRIPTION
Resistors			Sockets-Knobs-Jacks		
1-1	2	47 $\Omega$	100-M10	1	Indicator assembly
1-4	1	330 $\Omega$	432-3	3	Shielded connector
1-7	2	680 $\Omega$	434-15	1	7-pin miniature socket
1-9	1	1 K $\Omega$	434-16	1	9-pin miniature socket
1-3A	1	3.3 K $\Omega$ 1 watt	434-22	1	Pilot light socket
1-18	1	5600 $\Omega$	462-18	1	Skirtless knob
1-21	1	15 K $\Omega$	462-19	5	Skirted knob
1-24	1	33 K $\Omega$	Hardware		
1-26	2	100 K $\Omega$	250-2	4	3-48 x 1/4 screw
1-32	1	390 K $\Omega$	250-7	3	6-32 x 3/16 screw
1-33	1	470 K $\Omega$	250-8	2	#6 x 3/8 sheet metal screw
Condensers			250-9	8	6-32 x 3/8 screw
21-3	1	10 $\mu$ mf (.00001 $\mu$ fd)	250-13	1	6-32 x 1 screw
21-7	1	33 $\mu$ mf (.000033 $\mu$ fd)	250-15	1	8-32 x 1/8 set screw
21-11	1	150 $\mu$ mf (.00015 $\mu$ fd)	250-83	2	#10 x 1/2 handle screw
21-16	6	.01 $\mu$ fd	251-1	2	6-32 spade bolt
21-27	1	.005 $\mu$ fd (5000 $\mu$ mf)	252-1	4	3-48 nut
23-8	1	.02 $\mu$ fd	252-3	20	6-32 nut
23-28	1	.1 $\mu$ fd	252-7	5	Control nut
25-7	1	20-20 $\mu$ fd 150 v	253-10	4	Control nickel washer
26-17	1	450 $\mu$ mf dual tuning	253-22	3	3/4 flat washer
Controls-Switches			254-1	17	#6 lockwasher
10-32	1	1 megohm control	254-4	5	Control lockwasher
19-18	1	1 K $\Omega$ control with switch	259-1	5	#6 solder lug
63-67	1	5 position band switch	Clips-Plugs-Wire		
63-69	1	2 position modulation switch	89-1	1	Line cord
63-70	1	3 position attenuator switch	207-3	1	1/8" cable clamp
Coils-Chokes Transformers			260-1	2	Alligator clip
40-47A	1	Oscillator coil band A	340-2	1	length #20 bare wire
40-47B	1	Oscillator coil band B	343-3	1	length Shielded test lead
40-47C	1	Oscillator coil band C	344-1	1	roll Hookup wire
40-47D	1	Oscillator coil band D	345-1	1	length Shield braid
40-47E	1	Oscillator coil band E	346-1	1	length Spaghetti (sleeving)
46-1	1	AF choke	432-1	1	Shielded plug
54-2	1	Power transformer	Chassis-Panel-Manual		
Tubes-Lamps-Rectifiers			90-14	1	Cabinet
57-2	1	Selenium rectifier	200-M54	1	Chassis
111-4	1	6C4 tube	200-M55	1	Sub-chassis
111-25	1	12AU7 tube	203-26F67	1	Panel
112-1	1	#47 pilot light	211-4	1	Handle
Grommets-Feet-Terminal Strips			595-73	1	Instruction Manual
73-1	6	3/8 grommet			
261-1	4	Rubber feet			
431-2	2	2-lug terminal strip			
431-3	2	3-lug terminal strip			